Jan. 26, 1960 A. H. ETT 2,922,893

DOCUMENT IDENTIFYING SYSTEM

Filed Oct. 15, 1954 2 Sheets-Sheet 1

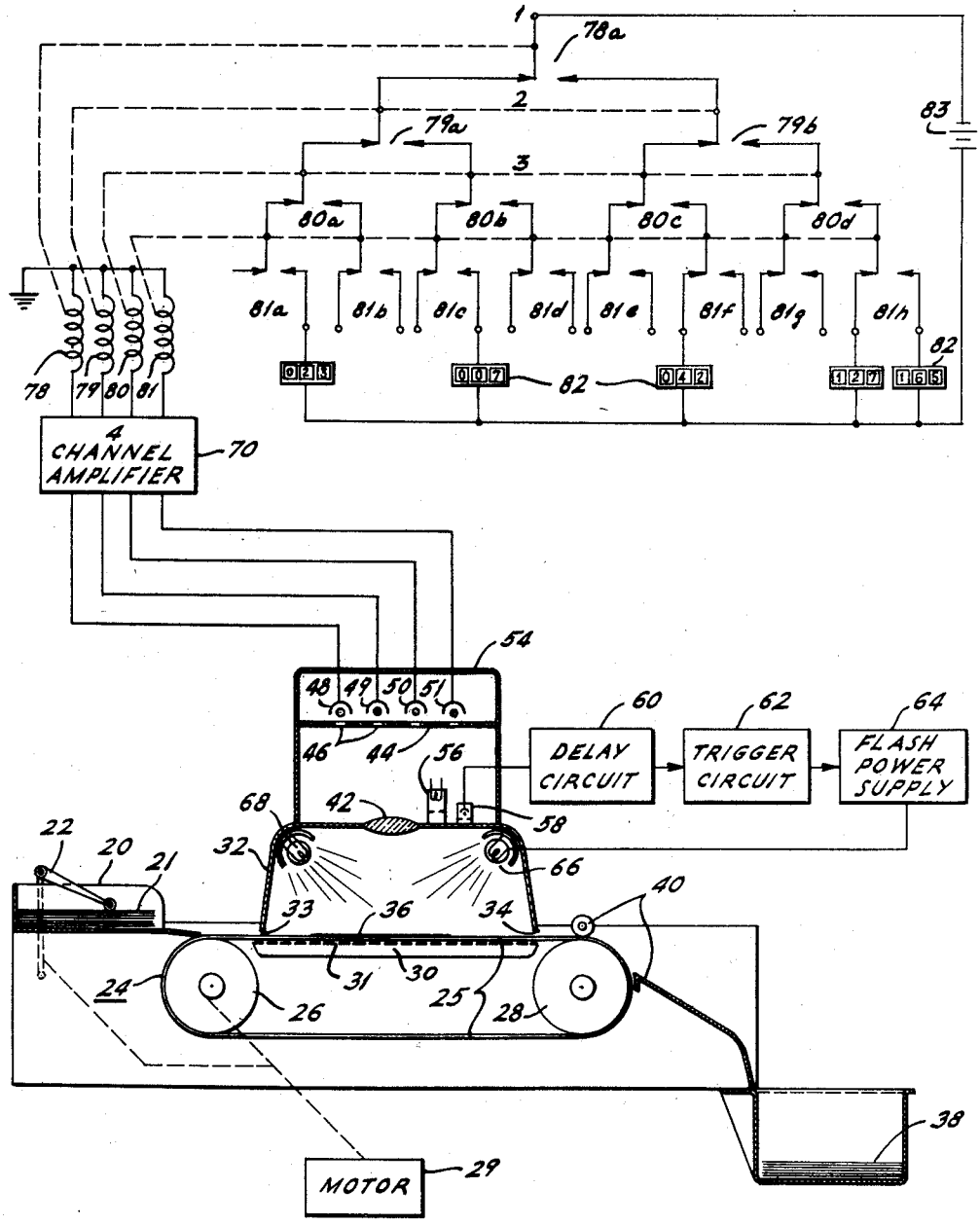

FIG. 1.

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FIG. 2.

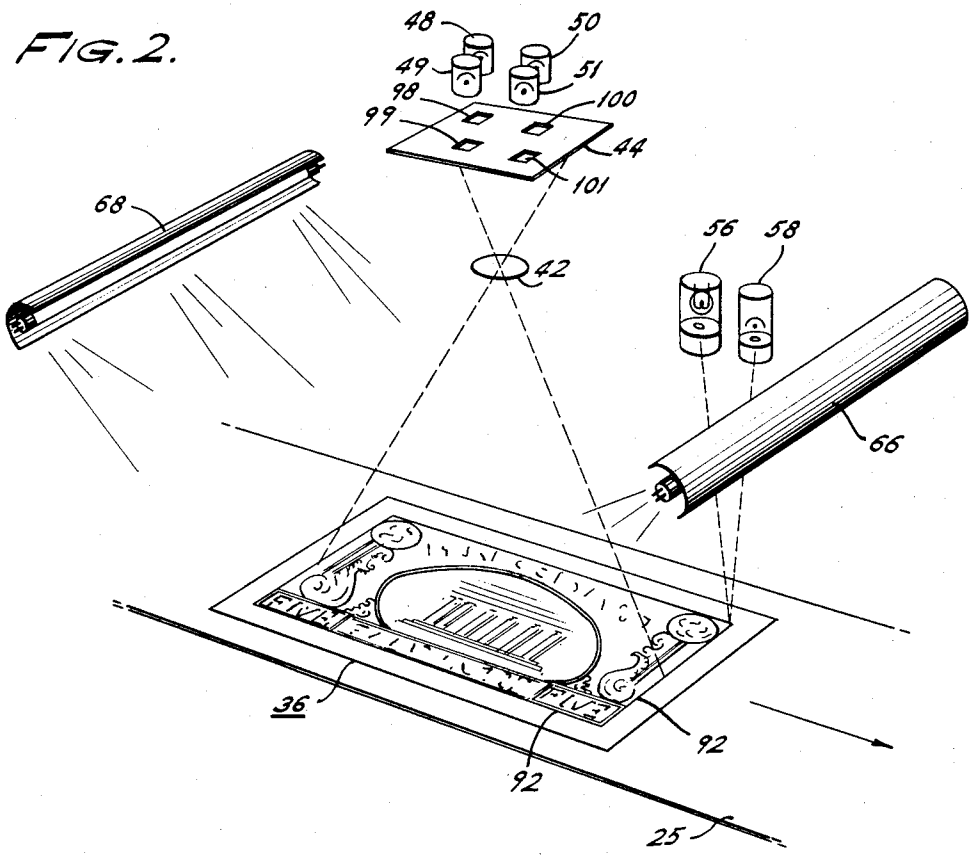
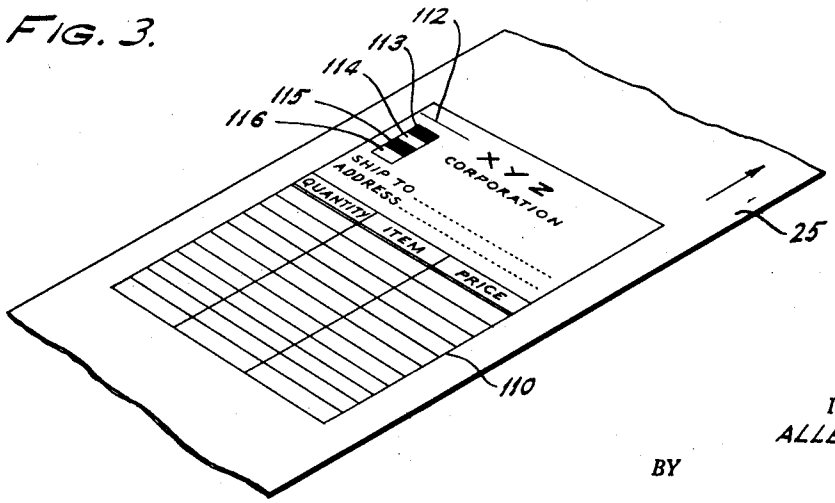


FIG. 3.



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DOCUMENT IDENTIFYING SYSTEM

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2 Claims. (Cl. 250—219)

The present invention relates to document identifying means and more particularly to means for producing distinctive electrical signals representing documents of known characteristics.

Banks, large department stores and other business establishments are faced with the problem of counting, sorting and maintaining an accurate record of many documents handled daily. The documents may be sales slips, shipping orders or United States or foreign currency accepted in payment for goods sold.

Sorting and counting these many documents by hand is a tiresome and time consuming process. This process relies on a visual examination of the document by a clerk and his mental interpretation of what he has seen.

Systems have been proposed for sorting such documents automatically. In general these systems rely on the registration of light and dark areas of the document (or the optical images of these areas) with an apertured mask or a bank of photocells. The chief disadvantage of such prior art systems is that the document must be immobilized in a prechosen position while the identification is being made. The mechanism required to transport the document to the place where the identification is to be made, immobilize the document, and then remove the document after the identification is complete, is complicated, expensive and extremely difficult to adjust for proper operation. Furthermore, some prior art systems rely on the edges of the document for their positioning information. If the identifying areas are not in proper register with the edges of the document, the prior art systems may give a false identification.

Therefore it is an object of the present invention to provide a document identifying system in which the document is identified while in motion through the system.

A further object of the present invention is to provide an electro-optical document identifying system which is not affected by certain variations in the position of the identifying areas on a document.

Still another object of the present invention is to provide an electro-optical document identifying system which does not require immobilization of the document for examination purposes.

These and other objects of the present invention are realized in a system which photoelectrically views areas of the document which are disposed in a fixed, known relationship to a reference mark appearing on the document. The documents are caused to pass through the viewing area on a suitable continuously moving conveyer. Means responsive to the above-mentioned reference mark cause the document within the viewing area to be illuminated for a very short time interval. The image of the illuminated document is caused to actuate a suitable photoelectric identifying system which provides an output signal which is representative of the type or class of the illuminated document.

For a better understanding of the present invention together with other and further objects thereof, reference should now be made to the following detailed description which is to be read in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic drawing partially in section of a preferred embodiment of the invention;

Fig. 2 is a schematic drawing illustrating the operation of a system for identifying United States currency; and

Fig. 3 is a second schematic drawing illustrating the operation of a system for identifying shipping orders or the like.

Turning now to Fig. 1, the embodiment of the invention there shown comprises a bin **20** into which documents **21**, for example U.S. currency of various denominations, may be placed. Preferably bin **20** corresponds in width to the width of the documents so that the longitudinal axes of the documents all lie in a common vertical plane. An intermittent motion device **22** is provided for feeding the bills into position on a conveyer **24**. Feeding device **22** may be of the type found on duplicating machines, printing machines or the like where it is necessary to feed one sheet of paper at a time. Feeding device **22** merely advances the documents to a position on the conveyer **24**, one at a time, and without changing the direction of the longitudinal axis. It is not required to place the documents in any preselected position along the conveyer **24**. Conveyer **24** comprises an endless belt **25** which is carried on rollers **26** and **28**. Suitable driving means such as a motor **29** is mechanically coupled to roller **26** for driving the belt. This motor also controls feeding device **22**. Guide means (not shown in Fig. 1) may be provided for insuring that the longitudinal axes of the documents are aligned with the direction of motion of the belt **25**. Hold-down means, such as an evacuated chamber **30** having a perforated upper plate **31** disposed beneath belt **25**, are provided to maintain the documents in position on belt **25**. The documents fed from bin **20** to conveyer **24** are carried by belt **25** to a position within housing **32**. Housing **32** forms a light shield over a portion of the moving belt **25**. However, openings **33** and **34** are provided in the regions adjacent the belt to permit documents **21** to enter and leave housing **32**. Document **36** is shown within housing **32** in the position in which the identification is made.

The embodiment of the invention shown in Fig. 1 is arranged to count but not sort documents of different types. Therefore a receiving bin **38** is provided adjacent the right hand end of the belt **25** for receiving the documents after they pass through housing **32**. Stripping and guiding mechanism **40** is provided for removing documents from the moving belt and for depositing them in receiving bin **38**.

A lens **42** is provided in the upper wall of housing **32**. Lens **42** is arranged to project an image of document **36** on a mask **44** having openings **46** provided at selected locations therein. In Fig. 1 the openings **46** in mask **44** are shown as all lying in the plane of the section. However, as shown in Fig. 2, these openings may be positioned in any selected point on the area covered by the image projected on mask **44**. Photocells **48**, **49**, **50** and **51** are disposed behind the openings **46** in mask **44**. A housing **54** surrounds photocells **48** through **51** and mask **44** to prevent stray light from affecting the operation of the photocells.

A lamp **56** is positioned so as to project a spot or a line of light on a selected position on belt **25**. A photocell **58** is arranged to view only the limited area illuminated by projection lamp **56**. Photocell **58** is connected to the input of delay circuit **60** which is arranged to delay pulse type signals received from photocell **58** by a few microseconds or a few milliseconds depending upon the rate of travel of belt **25**. The signal from delay circuit **60** is supplied to trigger circuit **62**

which controls the operation of flash power supply **64**. Trigger circuit **62** may be arranged to respond only to pulses of a preselected duration. Power supply **64** supplies energy to two flash lamps **66** and **68** which are positioned so as to illuminate the area of the belt **25** which is imaged on mask **44**. Flash lamps **66** and **68** are preferably of the gaseous discharge type which provide a microsecond flash in response to trigger signals supplied by photocell **58**. The circuits represented by blocks **60**, **62** and **64** are in current use in photographic equipment and require no further description.

Photocells **48** through **51** are connected to individual inputs of a four channel amplifier **70**. The outputs of these four channels control, respectively, relays **78**, **79**, **80** and **81**. Relay **78** has one set of contacts **78a** which form a single pole, double throw switch arrangement. Relay **79** is provided with two sets of contacts, **79a** and **79b**, while relays **80** and **81** have four sets, **80a**–**80d** and eight sets **81a**–**81h**, respectively. The relays are connected as shown in Fig. 1 to provide 16 possible combinations of relay positions each of which provides but a single closed path from the armature of relay **78** to one of the 16 contacts on relay **81**. Electrically operated registers **82** are provided for all or a selected few of the contacts of relay **81**. A power source such as battery **83** is connected between the armature of relay **78** and a common terminal of registers **82**. Registers **82** are so constructed that they step by one number each time the circuit is closed to power supply **83**. Registers of this type are available from a number of manufacturers.

In order to understand the operation of the system of Fig. 1 it will be helpful to consider for a moment the engraving employed on United States currency. Since 1934 the design appearing on the back of a bill of a given denomination is the same whether the bill happens to be a Silver Certificate, a Federal Reserve note or a United States note. This is true only of the design appearing on the back of the note, the design on the face of the note being varied to indicate the authority by which it is issued. The design appearing on the back of the U.S. currency varies considerably from denomination to denomination. This variation between denominations and the uniformity for any one denomination makes it possible to sort U.S. currency into denominations by electro-optical means. The differences in the face of the bills of any one denomination may be utilized to sort Silver Certificates, Federal Reserve notes and other currency.

It is well known that great care is taken in preparing the plates from which U.S. currency is printed. Therefore the design is always uniform on the bills. However, as will be seen from the examination of bills of any one denomination, the trimming of the bills is far from uniform. That is, the design is not always centered on the paper blank. This irregularity in the location of the design on the bill makes it impossible to use the edge of the paper as a reference line for controlling the identifying system. However, on bills of all denominations there is a fine green line which entirely surrounds the design and is accurately positioned with respect to the remainder of the design. It is this line that applicant proposes to use as a reference.

In Fig. 2, **36** is a schematic representation of a $5.00 bill placed face down on conveyor belt **25**. Parts in Fig. 2 corresponding to similar parts of Fig. 1 have been given like reference numerals. As shown in Figs. 1 and 2, belt **25** carries bill **36** along until a point is reached where the light from lamp **56** strikes line **92** on bill **36**. The dark color of this line causes a sharp decrease in intensity on the light arriving at photocell **58**. This change in light intensity is converted into an electrical pulse which causes delay circuit **60**, trigger circuit **62** and power supply **64** to energize discharge lamps **66** and **68** for a very short interval, for example a few microseconds. As mentioned above, trigger circuit **62** may include a pulse length discriminator circuit which permits trigger circuit **62** to respond only to discontinuities having a width equal to the width of line **92**. The pulse length discriminator circuit prevents trigger circuit **62** from triggering power supply **64** when the edge of the bill **36** or some foreign object passes through the spot of light projected by lamp **56**. The duration of the flash of light from lamps **66** and **68** is so selected that bill **36** moves through a distance which is small compared to the minimum detail that can be recognized by photocells **48** through **51**. The image of the momentarily illuminated bill is focused on mask **44** by lens **42**. As shown in Fig. 2 mask **44** has openings **98** through **101** formed therein. These openings may be transparent openings in an otherwise opaque mask or they may be black and white negatives of certain selected areas on the bill, that is, mask **44** may be generally opaque whereas each of the openings **98** through **101** has opaque and transparent areas corresponding to light and dark lines within each selected area. The position of the areas **98** through **101** on mask **44** must be chosen with due regard to the document to be identified. In the case of U.S. currency they are so selected that the combination of light and dark areas focused on this mask for bills of various denominations will be different for each denomination to be identified. For example, aperture **98** may correspond to the area lying somewhere in the relatively clear field to the left of the oval on a $5.00 bill, aperture **100** at a point in the field directly below the M in AMERICA, aperture **99** to a point on the vertical center line of the Lincoln Memorial and approximately half way up the column and aperture **51** to a position in the scroll work immediately above the V in the word FIVE in the lower right hand corner. Under these conditions an image of a $5.00 bill focused on mask **44** would superimpose light areas on apertures **98** and **100** and dark areas on apertures **99** and **101**. The light areas on apertures **98** and **100** would cause relays **78** and **80** to be energized, thus completing a circuit to the left hand contact of the contact pair **81***f* of Fig. 1. This would cause the counter associated with this contact to register an increase of one number. Suppose that the next bill in line happens to be a $1.00 bill. The apertures in mask **44** will correspond to the following regions on a $1.00 bill. Aperture **98** will now correspond to an area lying somewhere in the circle at the left of the $1.00 bill, aperture **99** to the clear area between the left leg and the diagonal of the letter N which is centered on the back of the bill. Aperture **100** will correspond to an area lying in the scroll design above and to the right of the E, and aperture **101** will correspond to a clear area in the numeral 1 appearing at the lower right hand corner of the bill. This clear area is the one that appears above the word ONE which overlies the numeral 1. An image of the $1.00 bill focused on mask **44** will thus cause dark areas to be imaged on apertures **98** and **100** and light areas to be imaged on apertures **99** and **101**. This will cause voltage to be supplied to the right hand contact of pair **81***c*. The counter associated with this contact will indicate that a $1.00 bill has passed through the counting device. Ten and twenty dollar bills will cause other different combinations of light and dark areas to be imaged on mask **44** and cause different counters to be actuated.

It was mentioned earlier that, for proper operation of the system, the currency must be stacked with a particular orientation in bin **20**. However, the system can be arranged to accept documents in any orientation. One possible way of accomplishing this result with United States currency is to select the positions of the apertures in the mask so that the same combination of light and dark areas is imaged on the apertures for any of the four possible orientations of a bill of a given denomination. However, if a large number of denominations

are to be counted, the selection of the appropriate areas becomes very difficult and more than four apertures may be needed for proper identification. A second solution is to provide sufficient combinations so that there are four combinations, one for each possible orientation, available for each denomination. The four combinations may operate a single register or they may operate separate registers.

An embodiment of the invention which recognizes only one orientation of each denomination can also be used to count non-oriented bills provided that the apertures are so selected that a misoriented bill of one denomination will not register as a bill of another denomination. This is done by running the stack of bills through the system four times, each time changing the orientation of the stack without changing the relative orientation of the bills within the stack. The time required for this last described system to count a stack of bills can be reduced if sorting means are added at the output which separates the counted bills from the misoriented bills. The sorting means may be made responsive to all combinations of light and dark areas which do not identify bills of desired denominations. For example, suppose a system is arranged to count bills of five different denominations. Suppose further that means are provided for diverting improperly oriented bills from receiving bin **38** to a similar bin. In such an arrangement properly oriented bills of the five different denominations would pass through the system and would be counted and deposited in bin **38**. Bills not corresponding to these five denominations either because of their orientation or because they are of a different denomination or counterfeit would be deposited in a separate bin. The bills in this separate bin would then be replaced in bin **20** with their orientation reversed. In this position one or more bills in the replaced stack may have the proper orientation to be counted by the system. These bills will be deposited in bin **38**. The bills still not corresponding to any of the selected relay combinations will again be deposited in the auxiliary bin. The step of replacing the bills in bin **20** and again running them through the sorting and counting system may be repeated for the other two possible orientations of the bills. After four trips through the identifying system the bills appearing in the reject bin will be only those bills not corresponding to the denominations to be counted. The addition of the sorting device not only reduces the total number of bills passing through the system since properly oriented bills are not recirculated, but it also causes all of the bills to be placed in proper orientation in the final stack. Sorting machines for directing documents into one channel or another in response to a control signal are well known in the paper handling art and their addition to a system of the type shown in Fig. 1 may be accomplished without invention. As mentioned earlier, the number of passages of the bills through the system may be reduced by so selecting the identifying areas on the bill that two or more different indications are provided for each denomination. One combination will identify a bill when the back of the bill is up with the right hand of the design leading as the bill passes along belt **25**. A second combination will identify the bill with the back up but with the left hand edge of the design leading. The system will then identify all bills of the selected denominations which were oriented with their backs up. If the rejected bills are inverted and passed through the system, the system will then count all the remaining bills of the selected denominations. It is obvious that areas employed for identification must be chosen with care so that a design appearing on the face of one bill does not throw the same combination of light and dark areas on mask **44** as a combination that identifies a bill of a different denomination.

It should also be clear from the foregoing discussion that means may be added for sorting the bills according to denominations. This involves merely the addition of appropriate sorting devices which respond to the same combination of relay energizations as the counters of Fig. 1.

Fig. 3 illustrates a document **110** such as a shipping order which has an identifying code imprinted on the upper left hand corner of the document. This code consists of a reference line **112** corresponding to the green line on the U.S. currency. Immediately below line **112** are four squares **113** through **116** which are employed in the identifying process. The code shown in Fig. 3 in which squares **113** and **115** are dark and squares **114** and **116** are light represents but one of 16 possible combinations of the four squares. The coding may be placed on the document **10** by printing, stamping or any other suitable method. Alternatively, line **112** and the outline of squares **113** to **116** may be printed on the document and the appropriate squares blacked in by the shipping clerk. The code may represent the amount of the transaction involved, the destination to which the material mentioned on the document is to be shipped or the number and nature of the items listed on the slip. Several columns of squares may be employed for providing more than one item of information. Each column will control a separate bank of relays. Relays **78** through **81** may control either counting or sorting circuits or a combination of counting or sorting circuits.

As the foregoing discussion indicates, the documents identified by the system disclosed herein move continuously through the system on conveyer belt **25**. The images of these documents are effectively immobilized by the short duration flashes supplied by lamps **66** and **68**. The image focused on mask **44** is identified by photocells **48** through **51**. These photocells control relays **78** through **81**. The contacts on these relays in turn, control appropriate means for sorting and counting the documents.

If the documents to be identified are transparent with opaque markings or opaque with transparent markings, for example punched cards, the photocells may be placed on the opposite side of the document from the source of illumination. A lens system may be employed to project the transmitted image of the document on a mask or the mask may be located directly beneath the path travelled by the documents.

While I have described what at present are considered to be the preferred embodiments of the present invention, it will be recognized that various changes and modifications may be made therein without departing from the spirit and scope of the hereinafter appended claims.

Having now described my invention I claim:

1. A system for identifying currency having a design on at least one face thereof and a separate fine line at least partially surrounding said design, said system comprising a conveyer for transporting paper money, means for sequentially placing individual units of said paper money on said conveyer, a photoelectric means for providing a distinctive signal in response to the passage of the said line surrounding the design on the exposed face of said units through a preselected reference position along the path of said conveyer, means responsive to said distinctive signal provided by said photoelectric means for momentarily illuminating the unit which caused the generation of said distinctive signal, a mask, a lens system disposed between said mask and said unit of paper money for imaging on said mask said illuminated unit of paper money, said mask being formed with apertures therein at points corresponding to selected regions on said units of paper money, said regions being so selected that the relative reflectivities of the several regions are indicative of a selected characteristic of each of said units, and a plurality of separate means each responsive to the energy passing through a corresponding one of said apertures for generating a plurality of signals, a selected characteristic of each signal being indicative of the reflectivity of the region imaged on a corresponding aperture during said momentary illumination of said unit of paper money.

2. A system for identifying separate documents which have marked thereon a reference line having a reflectivity substantially different from that of the immediately adjacent portion of said document and a plurality of regions located at known positions with respect to said reference line, said system comprising a conveyor for transporting said documents, means for sequentially placing said documents to be identified on said conveyer with said reference line transverse to the direction of transport of said documents, photoelectric means for providing a distinctive signal in response to the passage of said reference line through a preselected reference position along the path of said conveyer, means responsive to the signal provided by said photoelectric means for momentarily illuminating the document which caused the said signal to be generated, a mask, a lens system disposed between said mask and said document for imaging on said mask said illuminated document, said mask being formed with apertures

therein at regions coincident with points on said image corresponding to selected ones of said regions of said document, separate means associated with each aperture for generating a signal indicative of the reflectivity of the region imaged on that aperture during said momentary illumination of said document, and means responsive to the signals generated by said last-mentioned means for providing a signal which uniquely represents which of said apertures have imaged thereon a region of preselected reflectivity.

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